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UNCONVENTIONAL NATRUAL GAS: AN ECONOMIC DRIVER FOR THE UNITED STATES ECONOMY

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Abstract

The United States is the largest consumer of energy in the world and has been for many decades. Due to the country's massive energy needs and lack of long-term energy policies, the United States has become reliant on foreign petroleum. This dependence on foreign energy threatens our national security and the domestic economy. It is imperative for our nation to decrease the dependence on foreign oil and we must begin to establish an energy strategy for the future. Unconventional natural gas gives the United States the opportunity to stimulate our economy while simultaneously decreasing our dependence on foreign oil.

The United States lies directly above one of the richest natural gas patches in the entire world, although most of this gas is contained in a rock formation known as shale. Until recently, this shale gas was difficult to extract and the drilling process was extremely expensive. A number of technological advances have given drilling companies viable extraction techniques for this unconventional shale gas. Before these drilling methods were fully harnessed, the United States was projected to run out of natural gas in the next few decades. Currently, estimates place our natural gas supply at approximately 100 years due to the large amount of shale gas and effective drilling techniques.

This study will offer a comprehensive analysis on the economic potential of the natural gas industry over the near term future. Benefits of increased gas production include job creation, stronger economic growth, the potential of exports and balance of payments benefits, decreasing our dependence on foreign oil and many other factors. The following analysis will demonstrate that, with appropriate commitments by the federal government and private corporations, natural gas can become an economic driver for the future of our country and create a much more stable domestic energy environment.

Table of Contents

Introduction

The United States' dependence on foreign oil is a well-documented situation that has plagued the nation for many years. Due to recent technological advances, the possibility of the natural gas industry becoming an economic driver that can help reverse this trend has become quite realistic. With enormous reserves and trillions of untapped cubic feet, natural gas could - materially change the United States economy and become a powerful force for job creation while also allowing the United States to begin to erase our dependence on foreign oil. For the purpose of this thesis, I have chosen to analyze the various possibilities for the natural gas industry in the near term future and document the beneficial effects of this industry on the United States economy. The basic question that my thesis will attempt to answer is as follows: with the increased potential of natural gas production through the use of new technologies, will the United States embrace natural gas as a new and powerful economic driver for the domestic economy?

The focus of my thesis will be a comprehensive macro-economic analysis of the future alternatives for the natural gas industry. The most basic benefit of increased natural gas production is the revenue and job creation that this growing industry could offer. In a recent Pennsylvania State University study written by Timothy Considine, a number of professors analyzed the economic benefits of the Marcellus Shale formation on Pennsylvania over the course of one year. According to the study, in 2008 Marcellus activity generated $2.3 billion in total added value to the state while creating 29,000 jobs and generating $240 million in local and state taxes. The study offers projections for the year 2020, estimating $13.5 billion in added value and the creation of 175,000 jobs for Pennsylvania alone. Although the Penn State study

analyzes the significance of the Marcellus Shale on the economy of a single state, the abundance of shale based gas makes the nationwide possibilities much greater.

The potential contribution from the natural gas industry to our national energy picture is quite substantial and yet the federal government has seemingly overlooked this form of energy while emphasizing other renewable sources that have little chance of making a material contribution in the foreseeable future. This thesis will attempt to show that natural gas is by far the most viable energy source for stimulating the economy and reducing our dependence on foreign oil while also being highly environmentally friendly.

This study will be divided into five general sections. The first section will be an overview of the technologies that have been developed over the past decade that have unlocked the giant untapped reserves that the energy industry now has at its disposal. The two main technologies involved in shale gas drilling are hydraulic fracturing and horizontal drilling. These are actually technologies that have been around for many years but it is the combination of the two that has created economically viable extraction techniques in shale formations. In order for the layman to understand the full potential of these technologies, it is essential to grasp the actual "science" behind the two technologies.

The second area of my thesis will be an overview of the United States' shale plays and reserves. It is imperative to understand that we have known for decades that there were massive amounts of natural gas trapped in the shale rock that occurs in many parts of the United States. Shale plays are basically non-porous rock formations that contain an abundance of natural gas that occupies the very small vacancies between the molecules within the formation. For instance, the Marcellus Shale, which sits directly under most of western Pennsylvania, has been estimated to hold 490 trillion cubic feet (TCF) of natural gas; an amount that is comparable to the size of

the Saudi Arabian oil reserves in BTU content. According to the Potential Gas Committee, due to the recent mastery of extracting shale gas, the United States has enough gas to supply the nation for the next 100 years!

After discussing the new technologies and the natural gas reserves, the third area of my thesis will transition into the more objective discussion of the macroeconomic benefits. In order to do this, I have built upon the expansive economic knowledge of my thesis advisor, Russell Chuderewicz, to help me explain my thoughts in an effective way. This section will encompass a discussion of various economic measures such as GDP and the amount of potential job creation.

The fourth section of my thesis will be a discussion on the current natural gas infrastructure and the future infrastructure that must be developed in order to handle the increased production. This will be a discussion on the types of changes that must be made in order to unleash the full impact of natural gas. Although it seems like a gigantic task to install an effective natural gas infrastructure, most of the core elements are already in place (natural gas pipelines and fueling stations).

The fifth and final section will be a discussion on the potential to eliminate foreign oil imports from countries such as Venezuela, Saudi Arabia, and Nigeria where political risk inherent in those countries could quickly translate into enormous potential economic issues for the United States were that supply chain to be interrupted. This hypothesis ties in with the overall objective of the "Pickens Plan", which is an alternative energy plan focused on ending our addiction to foreign oil. This final section will serve as a logical closing point, incorporating all of my analysis and observations.

Background of Technologies

It is important to understand what constitutes "unconventional natural gas" in order to comprehend why these technologies have changed the outlook for future production. According to the website "naturalgas.org", unconventional natural gas can come in a variety of different forms, including "deep natural gas, tight natural gas, shale gas, coal bed methane, geopressurized zones, and methane hydrates". The focus here will be on the extraction and exploitation of shale gas, which is natural gas contained in shale deposits that are approximately 350 million years old (nautralgas.org). Shale plays contain many thin layers of soft rock which at one time were sea beds and where the layers were developed over many millions of years and gradually compressed over the ages. As these layers were rich in organic material, the decaying material eventually produced gas that became trapped within the layers of rock. As compared to conventional natural gas, which is basically a confined reservoir of natural gas that migrated upward in the earth over millions of years until being caught underneath an impermeable "trap" of rock above making it easy to tap into, shale gas had historically been much more difficult to extract and therefore economically unviable.

There are two basic technologies that have enabled gas drillers to reach previously unobtainable reserves in an economically viable fashion. The first of these technologies is called directional drilling, which involves the drill bit literally being manipulated from the surface through the drill string to facilitate drilling in any direction. The capabilities of directional drilling have ultimately given rise to horizontal drilling, a method that will be discussed at length later on in this section. The second technology is called hydraulic fracturing and involves fluids being pumped under extremely high pressure down the drill pipe and out into the formation in

order to fracture the surrounding rock which releases the natural gas from the shale rock and allows it to migrate into the well bore. While both technologies have been in existence for some time, it is the combination of the two that has given E&P companies an economic extraction alternative. In the words of the energy investment firm Tudor, Pickering, Holt & Co, "Shale gas extracted via horizontal drilling and hydraulic fracturing has single handedly turned the United States from a nation of declining gas production to one of rising production".

According to Schlumberger Limited, "Directional drilling is the science of deviating a wellbore along a planned path to a target located a given lateral distance and direction from vertical. This is accomplished through the use of whipstocks, bottom-hole assembly configurations, instruments to measure the path of the well bore in three-dimensional space, data links to communicate measurements taken down-hole to the surface, mud motors, and special BHA (bottom hole assembly) components and drill bits, including rotary weight on bit and rotary speed to deflect the bit away from the axis of the existing wellbore". As can be seen, directional drilling is an extremely complicated and precise process. On a more basic level, directional drilling begins by entering the ground in a vertical manner, exactly like conventional down-hole drilling. The driller then uses a specialized tool to turn the drill bit in order to enter a gas producing zone at a specific angle. In conventional down-hole drilling, the entire drill string rotates along with the drill bit in one single motion. In directional drilling a specialized mud motor has mud pumped through it at high pressure to hydraulically create a turning motion, while the drill string itself does not rotate. As the drill bit begins to dig in a different direction, the drill string simply follows its path. This technology was originally developed to reach offshore reservoirs from land based drilling rigs; this is detailed below in *Exhibit A*. Directional

drilling allows the development of multiple wells from a single platform. Additionally, a simplified diagram of the directional drilling process is included below in *Exhibit B.*

Exhibit A

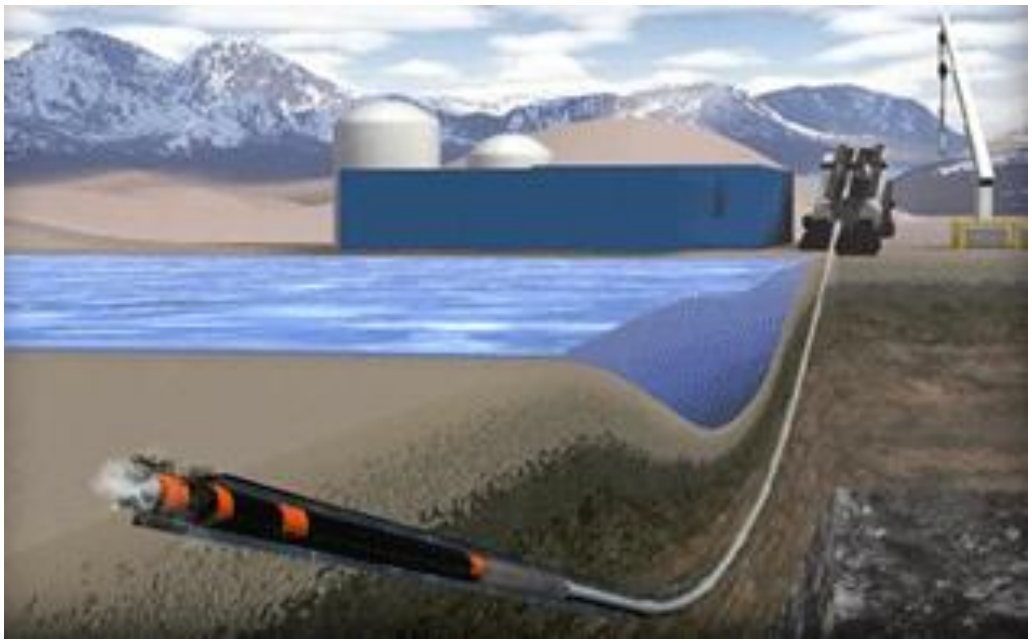
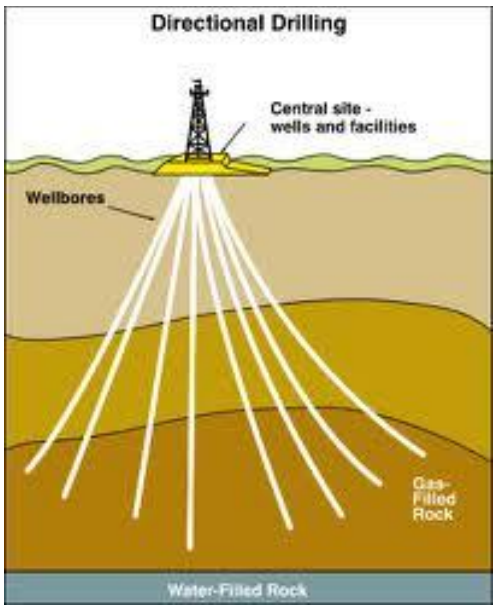


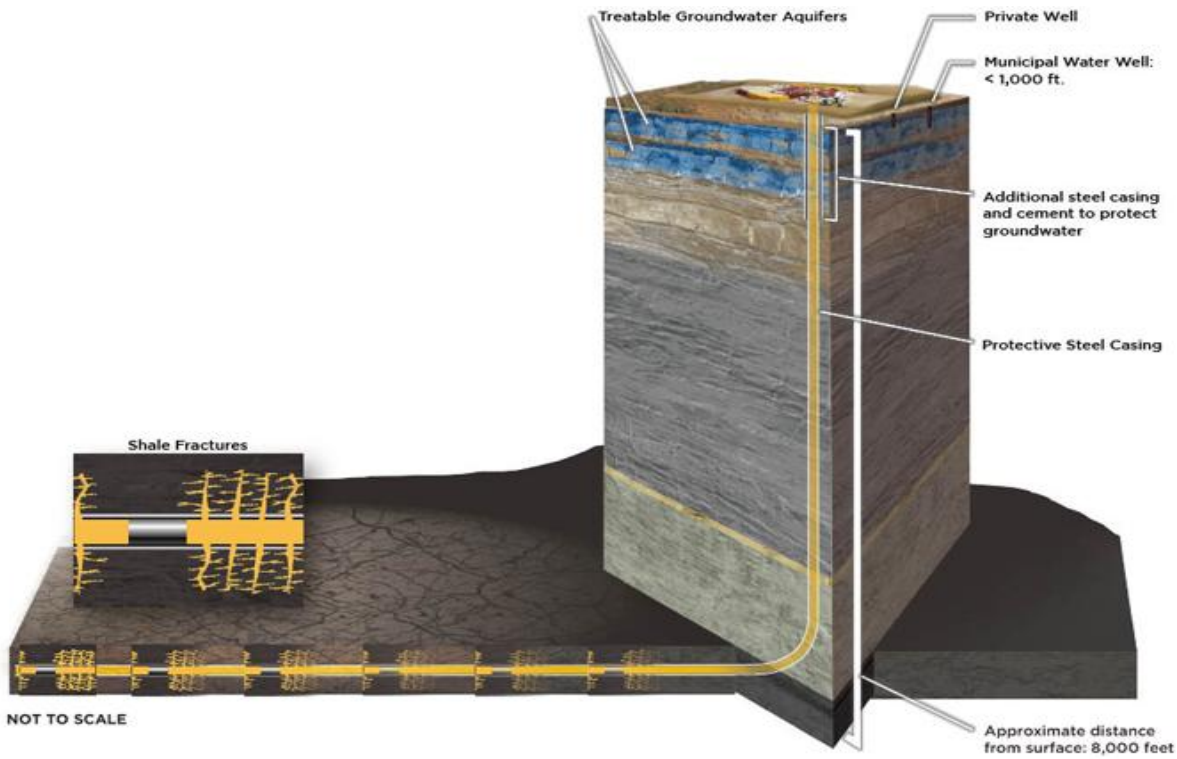
Exhibit B



Basic directional drilling has led to a similar gas drilling process known as horizontal drilling. This process is basically the same technology as directional drilling; it just implies that the drill bit turns the drill string to run in a horizontal manner for a certain distance. This is a crucial technology for natural gas drilling because it offers greater contact area with the producing zone of a shale gas reservoir. Since shale gas is not confined into one centralized zone, the drill pipe must be exposed to a large area of shale rock in order to extract an economically viable amount of gas. In order to visualize this, one could envision a series of small balloons tied together, all laying flat on the ground. Then picture a long metal spear as the drill pipe. If you angle the spear straight down, you are only able to pop one of the balloons. But if you turn the spear horizontally, you are able to pop all of the balloons at one time.

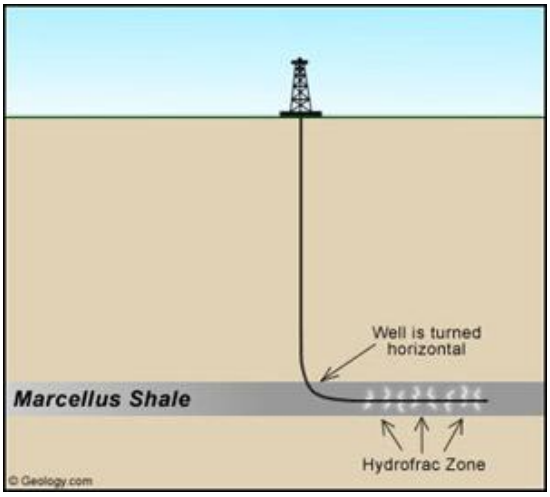
The second technology that has enabled gas drillers to exploit shale gas is known as hydraulic fracturing, or more simply "fracking". According to hydraulicfracturing.com, the fracking process can be simplified into six basic steps. First, "water, sand and additives, are pumped at an extremely high pressures down the wellbore. The liquid goes through perforated sections of the wellbore and into the surrounding formation, fracturing the rock and injecting sand or proppants into the cracks to hold them open. This process may be repeated multiple times in "stages" to reach maximum areas of the horizontal wellbore. When this is done, the wellbore is temporarily plugged between each stage to maintain the highest water pressure possible and get maximum fracturing results in the rock. Next, the frac plugs are drilled or removed from the wellbore and the well is tested for results. Finally, the water pressure is reduced and fluids are returned up the wellbore for disposal or treatment, leaving the sand in place to prop open the cracks and allows the gas to flow". This process is demonstrated below in *Exhibit C.*

Exhibit C



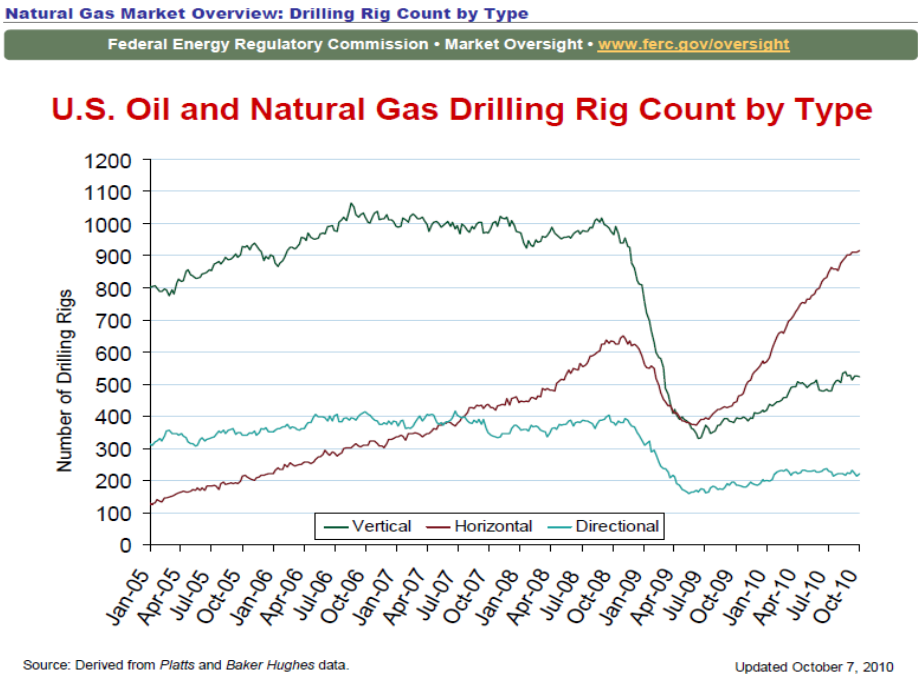
In more basic terms, hydraulic fracturing involves a mixture of water and sand pumped into the well at very high pressure. This specialized fluid flows through holes in the pipe that were created by controlled explosions in a process called perforating. These high pressure fluids flow through the holes in the drill pipe and into the rock, basically cracking the soft shale rock that is permeated with natural gas. Once this is done several times, the water pressure is lowered and the fluid flows back to the surface; the sand remains in the cracks to hold open the fissures that were created, allowing room for the natural gas to flow back into the drill pipe and up to the surface. A simplified diagram is supplied below in *Exhibit D.* Additionally, it is also important to note the combination of horizontal drilling and hydraulic fracturing demonstrated in *Exhibit D.*

Exhibit D



As previously discussed, neither of these complex technologies are new; in fact, they have both been in use for decades. But it is the recent combination of both technologies that has opened up new possibilities for natural gas extraction. As a testament to the influence of these combined technologies, refer to *Exhibit E* below.

Exhibit E



This is a graph taken from the Federal Energy Regulatory Commission plotting the use of the different drilling methods. The enormous dip in October 2008 was caused by the recent economic recession that led to an enormous decline in energy prices and caused all drilling activity to be greatly reduced. The important aspect to observe is that in the last two years, the use of horizontal drilling has surpassed vertical drilling for the first time in history. The sharp increase in horizontal drilling signifies the recent commitment by Exploration & Production companies (E&P) to extract the unconventional natural gas with these two technologies in unison.

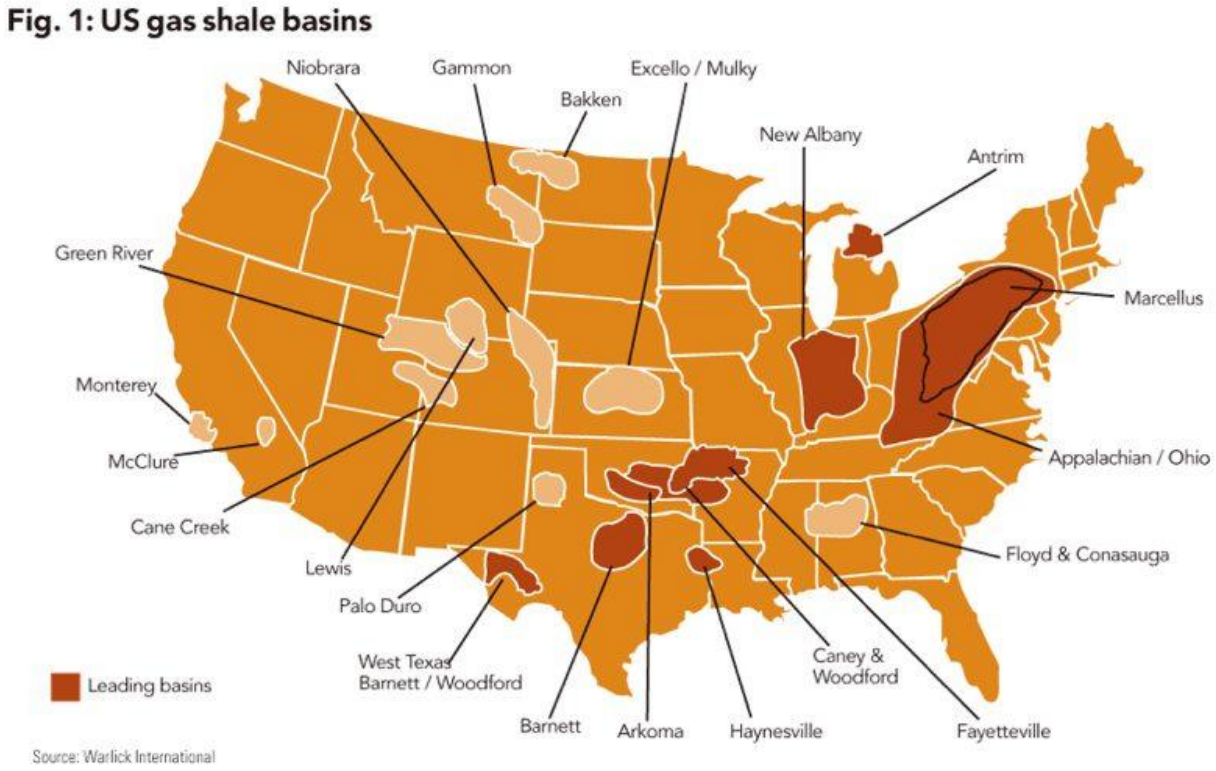
Horizontal drilling and hydraulic fracturing technology has opened up an entirely new frontier for the future of America's energy needs. The previously unobtainable gas that was trapped in the soft shale rock was nearly impossible to extract with either technology alone, not to mention prohibitively expensive. The precise combination of both technologies has given drillers an extremely reliable and economically feasible extraction technique for this unconventional natural gas trapped in the shale plays.

Overview of United States Shale Plays and Reserves

As explained in the previous sections, shale rock contains massive amounts of natural gas that has only recently been economical to recover. The continental United States is blessed with large amounts of shale rock and those geographic areas with high concentrations of shale gas have been labeled "shale plays". As you can see in *Exhibit F* below, there are over twenty shale plays in the United States. In the interest of maintaining a focused view, this analysis will concentrate on the six main shale plays that drilling companies are targeting. These six shale

plays are known as the “Big Six” and make up a substantial percentage of the overall gas supply in the United States.

Exhibit F



According to a report by Michael Hall of Wells Fargo Securities, the six main shale plays are the Barnett, Fayetteville, Woodford, Haynesville, Eagle Ford, and Marcellus Shale. In the next few pages I will explain the significance of each shale play, the geographic location of each formation, and the amount of natural gas contained in each of the “Big Six” respectively. In a later section, I will discuss the general economics behind the drilling activity of each shale play. The purpose of this section is to convey the physical characteristics of the United States’ shale plays at the current time period.

The evolution of "unconventional" gas drilling in the United States began in the Barnett Shale where hydraulic fracturing and horizontal drilling were first put into widespread use. This is the shale play that single handedly made the economics of shale gas financially viable. The Barnett Shale "is a large natural gas reserve encompassing more than 5,000 square miles and stretching across 20 counties in North Central Texas" (bseec.org). The Barnett encompasses the area around Dallas and Fort Worth and has been producing gas since the early 1980s. The most attractive parts of the Barnett Shale actually lie beneath some of the most populated areas in Texas. This is a potential issue for the full development of this shale, although horizontal drilling has made this a much more manageable dilemma. Shale rock under urban areas, such as downtown Fort Worth, can be reached by drilling horizontally from a less populated area. Initially, figures from the Barnett Shale Energy Education Council estimated that the Barnett Shale held more than 40 trillion cubic feet (Tcf) of natural gas and that "as of January 2010, there were just under 14,000 wells in the Barnett producing over 4.8 Bcf per day" (bsecc.org). A recent study from SCF Partners, a private equity firm, estimates that the Barnett Shale still has over 34 Tcf of recoverable gas and that there were 34 horizontal rigs working in the Barnett in February of 2010. Without the developments that took place in the Barnett Shale, unconventional natural gas would not be what it is today. The Barnett Shale is considered the "father" of modern shale drilling techniques and paved the way for all of the other shales.

The next shale play in the "Big Six" is the Fayetteville Shale which lies underneath the northern part of Arkansas and has over "8 Tcf of remaining recoverable gas" (oilshalegas.com). According to geology.com, the majority of the shale gas in the Fayetteville lies at approximately a 7,000 foot depth. This is considered to be a relatively shallow drilling depth which the drilling companies reach with relative ease. Before the introduction of these new technologies, Arkansas

had not been known as a gas producing state because almost all the gas in the state lies in shale rock. Once hydraulic fracturing and horizontal drilling took hold in the Barnett Shale, the Fayetteville Shale gave Arkansas a new hope at producing gas. According to the SCF Partners' study, there were 39 horizontal rigs drilling in February of 2010. Based on this statistic, it looks as though Arkansas is taking full advantage of their shale gas reserves.

Next in line is the Woodford Shale, which is located in the Southeastern part of Oklahoma and has over 11 Tcf of remaining recoverable gas. "Devon Energy drilled the first well in 2005 and since that time over 1,500 wells have already been drilled in the Woodford and there are many more to come" (oilshalegas.com). The "sweet spot" in the Woodford Shale lies at depths of 6,000-12,000 feet; this depth is fairly common among the "Big Six". As of February 2010, there were "29 horizontal rigs drilling in the Woodford Shale" (SCF Partners).

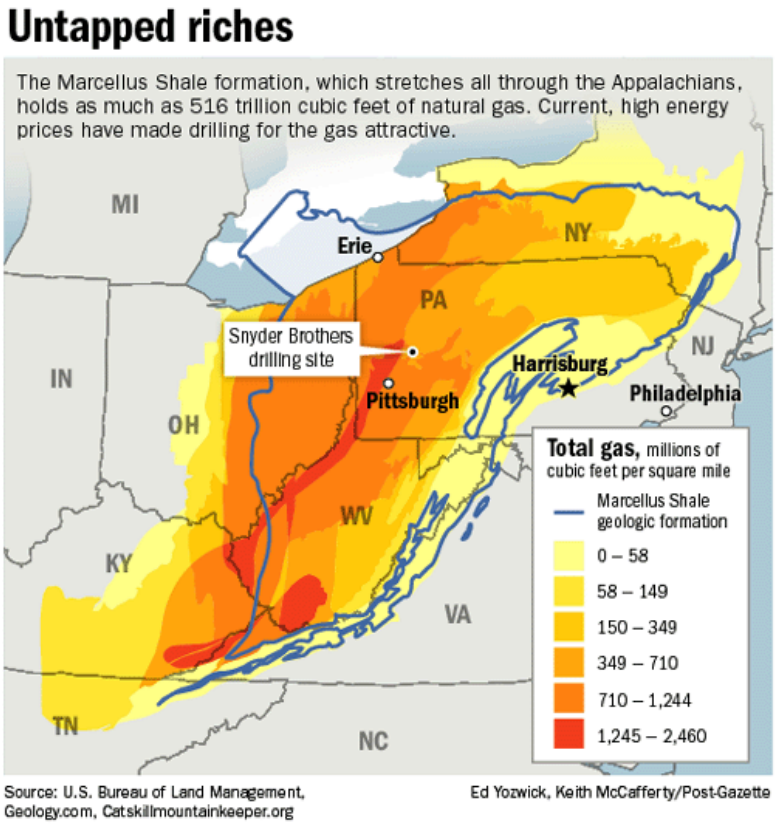
The next basin of the "Big Six" is the Haynesville Shale which lies approximately 10,000 feet below the surface of Western Louisiana and Eastern Texas. This shale has also been labeled the Bossier Shale in some parts of Louisiana, but is much more widely known as the Haynesville. According to myhaynesvilleshale.com, "the formations dip southward toward the Gulf of Mexico; thus, the formation is found deeper the further south oil and gas wells are drilled". The Haynesville contains some of the most porous rock in the country so it is extremely attractive to the drilling companies. While all shale rock is somewhat porous, certain shales have different measures of porosity and the Haynesville is amongst the most porous. Based on the SCF Partner's survey, the Haynesville is estimated to have over 42 Tcf of remaining recoverable gas. For such a relatively young shale play, the Haynesville could potentially be the third largest unconventional shale play in the United States.

The fifth shale out of the "Big Six" is known as the Eagle Ford and is also a relatively young shale play. It has been an extremely popular basin for the drilling companies because of its' permeable qualities, very similar to that of the Haynesville. The Eagle Ford is located in the southern part of Texas and "lies at about the 11,000 foot depth level" (oilshalegas.com). The Eagle Ford has "19 Tcf of recoverable gas remaining. As of February 2011 there were 135 horizontal rigs drilling in the Eagle Ford. The Eagle Ford has a thickness of about 475 feet, which is also very attractive for drilling companies. In the last few months, the drilling company EOG Resources announced a new discovery of gas in the Eagle Ford within the 500,000 acres that they own. This announcement attests to the fact that new pockets of shale gas are being discovered on a daily basis which means that all the estimates for recoverable reserves in these shale plays are most likely conservative. The Eagle Ford also contains large amounts of oil and NGL's (natural gas liquids) which are very valuable in their own right and adds substantially to the economics of drilling in the area.

Although all these shale plays are extremely large in terms of cubic feet of reserves, the final shale play in the "Big Six" dwarfs them all. If the E&P companies are going to refer to these six shale plays collectively as the "Big Six", this shale play should be called the "Huge One." The shale play that I am referring to is the Marcellus Shale, which lies below most of western Pennsylvania, the southern part of New York, the northern part of West Virginia and a small portion of eastern Ohio. As a student at Penn State University, it is interesting to think that the Marcellus Shale lies directly below my feet. According to the SCF Partners' survey, the Marcellus contains over 199 Tcf of remaining recoverable gas and had 154 horizontal wrigs drilling in February of 2011. Although SCF Partners is an extremely reliable source, their estimates for the amount of gas in the Marcellus might be somewhat conservative. In a recent

Penn State study conducted by Terry Engelder, he estimates the Marcellus Shale potentially contains upwards of 490 Tcf of recoverable gas. And in yet another study by the U.S. Bureau of Land Management, they project 516 Tcf of reserves in the Marcellus. The discrepancy between the three estimates can be attributed to a number of factors, including seismic measurements and other variables. When all is said and done it is irrelevant which estimate is more accurate; the pertinent fact is that the Marcellus Shale is one of the largest natural gas reservoirs in the world. In *Exhibit G* below, you can see the enormous scale of the Marcellus in terms of land mass and potential reserves. To put the size of the Marcellus in perspective, it would take someone over eight hours to drive from the southern tip of the shale in West Virginia to the northern tip in New York. Similarly, it would take about six hours to drive from the western limit to the eastern limit.

Exhibit G



Another interesting statistic that is noted in the SCF study is the number of years of inventory that all the reservoirs have remaining at the current rate of drilling. With the exception of the Marcellus, the "Big Six" shales have somewhere between 10-30 years of inventory remaining. As one more testament to the sheer size of the Marcellus Shale, estimates have projected the shale to have 135 years of inventory remaining. Even with the conservative estimate of SCF Partners (199 Tcf), the Marcellus has more untapped reserves than the other five shales combined. The Marcellus Shale is literally the "mother lode" of United States' shale gas.

Overall Economic Implications

Now that we have moved through the introductory material summarizing the technologies and unconventional shale plays that have brought us this new age of natural gas, we will move to a discussion on the economic implications of natural gas production on the United States. In the current age of growing populations and increasing energy demands, these trends are accompanied by dwindling natural resources and a much tighter regulatory environment for these resources. Because the environmental concerns of fossil fuels are a hot topic in today's political dialogue, natural gas has been receiving a legitimate amount of publicity due to its relative cleanliness in comparison to oil and coal. In addition to the environmental benefits of natural gas, there is another aspect of domestic gas production that is not widely flagged by the media or by the federal government: the potential of material domestic economic stimulus stemming from an increase in domestic production of this fuel source.

As I alluded to in the previous section, it is hard to fully comprehend the amount of unconventional shale gas that lies within the borders of the United States. Before these drilling technologies were developed and harnessed, the United States was projected to run out of domestic natural gas within the next twenty years. Currently, with the newly obtainable natural gas reserves contained within the shales, the United States is projected to have "over a 100-year supply of clean burning natural gas that we knew about but couldn't count on just a few years ago" (American Petroleum Institute, 2011). Robert Hefner, the head of GHK Exploration, was recently quoted in the Economist Magazine, "I used to say we were awash in gas, now I say we're drowning in it" (1). It is worth taking a moment to appreciate the significance of the size increase in extractable reserves in the United States; we have basically increased our obtainable reserves tenfold within the last twenty years! Very rarely do natural resource reserve estimates have an upward bias with the passage of time; if this was the case, there would be less concern about conserving resources. With these uncommon circumstances, the United States has been given the unique opportunity to utilize a virtual ocean of energy trapped beneath our feet in the shale rock. It is imperative that we seize this opportunity and use natural gas production to benefit our economy in a number of different ways. For the purposes of this economic analysis, I will make a distinction between the micro impacts and the macro impacts. I find this appropriate because there is a palpable difference between the economic impacts on local communities (micro) and the effects of natural gas on the United States' economy as a whole (macro).

When analyzing the micro economic impacts of domestic natural gas production, it is relevant to note the impacts on individuals and small communities. In a recent study published by Penn State professor Timothy Considine entitled "An Emerging Giant: Prospects and Economic Impacts of Developing the Marcellus Shale Natural Gas Play," Professor Considine

documents the fiscal benefits of the Marcellus Shale on the economy of Pennsylvania (with a micro focus). Considine classifies the microeconomic impacts of natural gas production in three distinct categories: direct, indirect, and induced impacts; "Direct spending by Marcellus producers to support drilling operations and the royalty and other payments to land owners will stimulate business activity throughout the economy and induce households and businesses to spend earnings on additional goods and services" (Considine ii). These direct benefits are all related to the revenues generated by the physical act of drilling for gas. The Exploration and Production (E&P) companies create a substantial amount of jobs and pay employees decent wages; they are also required to pay royalties to the owners of the land that they drill on and they must pay taxes (income, severance, or both) to the local, state and federal governments. All these direct cash flows are beneficial for the local economies and governments involved. Along with these direct benefits, there are a number of indirect economic benefits that are defined as having some degree of separation from the physical act of drilling and production. Literally dozens of different product and service enterprises support the drilling activity and generate revenue from the operations of E&P companies; "In developing mineral leases natural gas drilling companies employ the services of land management companies that in turn purchase goods and services from other businesses" (Considine 18). The physical act of extracting gas from shale rock is so complex that entirely new businesses have been created strictly to support certain aspects of the process. As a personal example, I recently had the opportunity to intern at a private equity firm that specializes in oil & gas service companies. One of the sectors that they were interested with is known as "water transfer," which is literally the movement and storage of the millions of gallons of water involved with the hydraulic fracturing of the shale rock. Dozens and dozens of new business enterprises have developed within the last fifteen years to deliver this specialized

service for natural gas drilling companies. Although "water transfer" is technically a separate venture from the physical act of drilling, its revenues are a direct result of increased drilling for natural gas. Additionally, the jobs and tax revenues generated by these respective service companies are also indirect benefits of drilling. This is just one of the dozens of specialized service outlets that have developed due to the unique needs of hydraulic fracturing and natural gas drilling operations in general. In the world of economics, these indirect ventures are known as production externalities because the variable costs of producing natural gas are not entirely paid for by the actual producers. These specialized businesses must spend additional capital to aid in the extraction of the gas, but they also reap the additional cash flow benefits supplied by the producers.

The third and final distinction that Professor Considine makes between the various economic benefits is categorized as induced impacts; "The wages earned by these employees increase household incomes, which then stimulates spending on local goods and services" (Considine 18). In other words, the salaries earned by all the employees involved with the direct and indirect aspects of drilling generate increased revenues for the entire community and the local economy benefits incrementally more than the monetary increase in salaries. Economists refer to this accelerated rate of economic activity as the "multiplier effect", which has been well documented through the Keynesian branch of economics. As a simplified example, "a $100 million project, to [build and operate a drilling rig], might pay $50 million in pure labor costs. The workers then take that $50 million and, minus the average saving rate, spend it at various businesses. These businesses now have more money to hire more people and to make more products, leading to another round of spending" (Investopedia). This multiplier effect is extremely relevant in the current time frame, with the United States having just emerged from

the depths of "The Great Recession." With the economy in a better state of affairs, consumers have more disposable income and are more prone to spending as opposed to saving; this is known as the marginal propensity to consume (MPC). Given the aftermath of the Great Recession and the associated credit constraints, the MPC is currently quite high, especially in the rural areas where much of the initial economic activity will be the strongest. The implication is that the induced impacts will be very significant in terms of boosting the multiplicative effect on economic activity. This multiplier effect can be seen below in *Exhibit H*, which is based on a hypothetical expenditure (employee wages) of $1,000 by a natural gas production company.

Exhibit H [1]

Marginal Propensity to Consume	0.7	0.8	0.9
Added Value to Economy	$ 3,333.33	$ 5,000.00	$ 10,000.00

Due to the fact that consumers are more prone to spending after a recession, the MPC is likely to be close to the upper bound of 1. As seen in *Exhibit H*, the expenditures of natural gas producers can be greatly enhanced by an environment that promotes a higher MPC. The spending patterns of consumers after a recession make the multiplier effect extremely powerful for the economy, which can be fully unleashed by natural gas drilling activity and the corresponding cash flows.

When taken together as a single phenomena, "the total economic impacts are the sum of the direct, indirect, and induced spending, set off from the expenditures by [natural gas] producers" (Considine 19). To put this information in the perspective of the actual production companies, a recent study conducted by Tudor Pickering Holt & Co and Reservoir Research

[1]The added value to the economy as seen in *Exhibit H* is calculated by multiplying the money multiplier and the initial expenditure of $1,000. The equation for the money multiplier is as follows: [1/(1-MPC)]. A MPC of 0.7 translates to the consumer spending 70% of their income on consumption and saving 30%.

Partners serves as an appropriate reference. The author notes that "shale drilling is profitable even at $4 -$5 gas [prices]. In Pennsylvania, where the economy has already been transformed by the drilling boom, producers told us it is simply worth it financially to go up against a wall of opposition to drill a well" (Pursell 4). This statement signifies the commitment from E&P firms to drill for natural gas even in the face of low gas prices and other negative variables.

In terms of microeconomic analysis, Professor Considine's study documents the impacts of natural gas on an isolated economy in an extremely thorough manner. Although this provides an obvious insight into the benefits of natural gas production, there is still an entire realm of macro-economic impacts that remain untouched by the professor's study. There are a vast number of macro benefits that result from increased production of natural gas and while many of these are directly related to the micro benefits, they must be altered to include the complete scope of the national economy. Within this section of my analysis, I will touch on a number of different macroeconomic effects that can be attributed to the increased production of natural gas. These benefits include direct and indirect job creation, decreasing the unemployment rate, tax revenue generation, Gross Domestic Product increases, additional value added, decreasing the budget deficit, increasing exports and stabilizing the balance of payments. In order to describe how natural gas production will affect each of these macroeconomic factors, I will analyze each respective category using well documented economic techniques along with demand and supply projections from domestic corporations. Due to the extremely volatile nature of the underlying economic activity, I will need to make my analysis somewhat more subjective in nature. The overall goal of my macro analysis is to provide some speculative insight into the beneficial effects of natural gas if the suitable resources are appropriated, both by the government and by corporations (I will touch on these issues in greater depth in the following section).

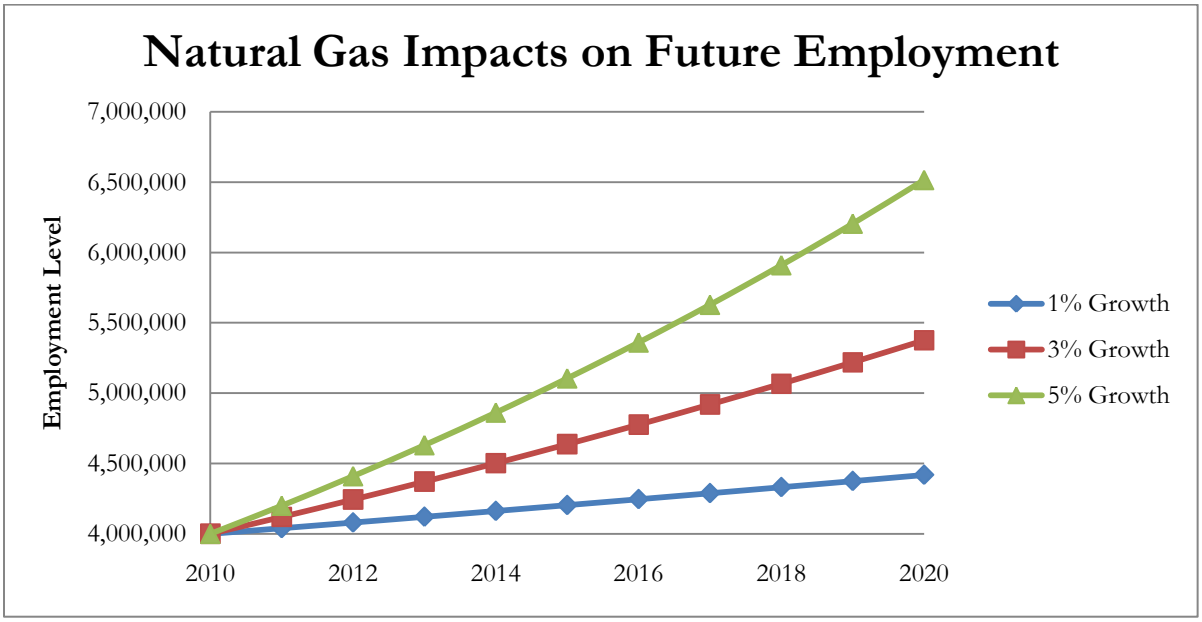
To begin this section of analysis, it is appropriate to document the same kinds of micro figures presented in Professor Considine's study and apply them to the macro economy. According to the American Natural Gas Alliance, in 2008 "natural gas companies employed roughly 622,000 Americans and indirectly sustained almost 2.2 million additional jobs in the same year". These figures were taken from an IHS Global Insight study that relied on estimates from the U.S. Bureau of Labor. Among the 622,000 jobs directly impacted by natural gas production, relevant sectors included "upstream exploration and production companies, midstream processing and pipeline companies, downstream local distribution companies, suppliers and onsite production companies, natural gas pipeline construction, and manufacturers of field machinery and equipment" (ANGA). Since this survey, which was conducted in 2008, it is only reasonable to assume that these figures have escalated quite substantially with the ramp up in activity. In fact, according to November 2010 figures from the American Petroleum Institute, "the natural gas industry supports nearly 4 million jobs" (2011). As I touched on earlier, the natural gas drilling process is so intricate and specialized that many types of product and service vendors rely entirely on natural gas to sustain themselves. There are numerous facets of extracting gas from the ground and getting it to the consumers that have only developed in recent years. The sheer number of sectors affected by natural gas production attests to the indirect job creation on a macro scale, similar to the findings of the Considine study.

For a nation that is just beginning to pull itself out of a serious recession, the unemployment rate and lack of job creation are the most pertinent economic concerns for both politicians and the general public. With natural gas currently supporting nearly 4 million jobs, the amount of job creation that could be obtained at a higher rate of production could singlehandedly reduce the unemployment rate. According to the Employment Situation Report

released by the federal government on February 4, 2011, the unemployment rate dropped 0.4%, from 9.4% to 9.0%. This 0.4% decrease corresponded to 86,000 workers becoming employed in the month of January. In order to put this in perspective, lets imagine that in 2011, the natural gas industry were to ramp up overall production by just 5%. Based on the API's estimate of 4 million jobs indirectly supported by natural gas production, this would mean that roughly 200,000 jobs would be generated or supported by the hypothetical 5% increase in 2011. Although the effect of these jobs on the unemployment rate is difficult to quantify, 200,000 jobs would certainly be beneficial for domestic employment, all stemming from a single industry's increased production.

The tremendous impact on job creation is not an isolated phenomenon occurring in only certain parts of the country. While Texas has the most direct and indirect natural gas related jobs, the influence of the natural gas industry on the economy is spread throughout the continental United States. In 2008, "31 states had at least 10,000 direct, indirect, and induced jobs related to natural gas" (IHS Global Insight). The United States happens to lay directly over one of the richest natural gas patches on the planet and an overwhelming majority of the states are beginning to take advantage. As another testament to size of natural gas job production, the same IHS study that approximated the 2008 direct and indirect job production at 2.8 million for natural gas only estimated 554,650 jobs sustained by the entire coal industry. For an industry that has only recently begun to gain credibility in the media, it seems as though the natural gas industry has been lurking in the shadows as a sleeping giant. In order to fully comprehend the potential job creation generated by the natural gas industry in future years, I have created *Exhibit I* below. This figure projects the employment levels generated from the industry at varying annual growth rates.

Exhibit I



The level of employment projected in *Exhibit I* refers to the total level of jobs supported by the natural gas industry, including both direct and indirect employment. The base level of employment is 4 million jobs in 2010, which relies on the aforementioned estimate taken from the American Petroleum Institute. As you can infer from the graph, if the industry was to grow at 5% per year, natural gas production would support approximately 6.5 million jobs by 2020[1].

Along with the potential job creation associated with natural gas production, the American Petroleum Institute also estimates that natural gas "adds over $385 billion to the national economy" and stimulates the country's Gross Domestic Product. In the previously cited study from IHS Global Insight, they note that "value added from natural gas related activities contributed 2.7% of U.S. output in 2008". Based on these figures, it appears that natural gas production is slowly becoming an economic juggernaut of the new age. With new rigs coming on

[1] Numerical data for estimates in *Exhibit I* can be viewed in Appendix 1

line everyday and the corresponding productivity gains, this industry has the potential to grow at an accelerating rate in the upcoming decades. To summarize the employment and financial impact of natural gas on the economy over the last few years, I have supplied a chart taken from the America's Natural Gas Alliance in *Exhibit J* below. Although the statistics are a few years old, it gives a good illustration of the type of growth the industry has been experiencing.

Exhibit J

Natural Gas Impact on the U.S. Economy

	Direct	Indirect	Induced	Total
Employment				
2008	622,411	723,102	1,482,801	2,828,314
2007	586,501	693,957	1,412,401	2,692,499
2006	517,233	620,061	1,282,248	2,419,542
Labor Income (billions of dollars)				
2008	69.9	48.9	62.5	181.2
2007	66.1	47.0	59.5	172.6
2006	60.1	42.6	54.0	156.7
Value Added (billions of dollars)				
2008	172.1	92.5	120.1	384.7
2007	161.9	88.8	113.8	364.4
2006	146.6	81.1	103.3	330.9

Source: IHS Global Insight, 2009

To further emphasize the economic impacts of natural gas, it is worth discussing recent views of the largest producers of natural gas. Throughout this section I have only referenced academic and research generated statistics; by nature, these estimates are likely to be conservative because these entities have nothing to directly gain from increased production of natural gas. On the other hand, the large E&P companies investing resources in natural gas production are likely to be less conservative on their predictions. That being said, I believe it is

quite relevant to analyze the opinions of corporations who are physically producing the natural gas. In a 2011 Wall Street Journal article entitled, "Big Oil Bangs the Drum for Natural Gas," James Herron notes that "ExxonMobil, Royal Dutch Shell and now BG Group have been arguing that significant changes are afoot in the unglamorous world of natural gas that could have a big impact on patterns of energy consumption and the balance of power in volatile energy markets." The biggest oil producers in the world are embracing the idea of natural gas as a potential economic driver and are investing accordingly. Before the extraction techniques were refined to reach such huge natural gas reserves in the United States, these companies did not see gas as a viable alternative to petroleum. Herron continues, "The big driver of this shift is supply… A boom in production of natural gas trapped in shale rock has already transformed the fortunes of the U.S. Just a few years ago, North America was grimly looking at the prospect of growing dependence on foreign gas. Now it's sitting on so much of the stuff that people are seriously discussing export projects" (Herron 2).

This massive increase in supply has created differing views on the eventual impacts. Daniel Fineren of the International Energy Agency has predicted a "global gas glut lasting until 2020 due to an oversupply of natural gas on the world market" (Fineren 1). Although I understand the validity of his concerns, Fineren seems to be ignoring the possibility of an increase in demand accompanying the supply boost. "Shell, ExxonMobil and BG Group, all big producers of natural gas, disagree [with a global gas glut]. Rather than swamping the market, they say the extra supply will stimulate greater use of gas either because it is cheaper, more secure and less carbon intensive than other energy sources" (Herron 3). These corporations believe that the increase in supply gives the United States an opportunity to harness the potential of natural gas created by the shale reserves. Another interesting facet of this argument is the idea

that natural gas is a more secure fuel source than petroleum due to the geography of supply locations. Most of the world's petroleum is located in the Middle East or other areas plagued by unstable social conditions. Since so much of the global natural gas supply is located in North America, the stable political and social environment makes natural gas prices less susceptible to drastic fluctuations. Take the February 2011 situation in Egypt as an example; social unrest stemming from President Mubarak's harsh regime launched the entire country into disarray. Since Egypt has control of the Suez Canal, a major distribution channel for petroleum, the turbulence in Egypt caused the price of petroleum to rise steeply. Major corporations are arguing that situations similar to this will not be a problem for the supply of natural gas because it is located in a much more stable region of the world. Additionally, risk and uncertainty play a vital role in the decision making process of businesses; with the greater stability of natural gas vs. petroleum, domestic firms will be more willing to invest larger amounts of capital for extracting and producing natural gas.

Over the course of history, it has been proven that reliability and affordability are major factors for any type of energy source. Natural gas has a major comparative advantage in both of these areas. Due to this fact, major E&P firms are predicting sizable increases in natural gas demand in the next twenty years. "ExxonMobil predicted a shift toward natural gas by businesses and governments precisely because it is so reliable and affordable… BG Group, in its long term strategy update, was particularly bullish, predicting gas demand will grow 3% a year between now and 2020" (Herron 2). As noted earlier, the "global gas glut" predicted by the Daniel Fineren does not account for the potential increase in demand that these firms are speculating. To put these numbers in perspective, "The increase in demand by 2020 will be equivalent to more or less the entire current North American gas market. Once you take into

account the need to offset the natural decline in production from existing resources, more than two North America's worth of new gas supply will be needed to meet this demand" (BG Group 1). Basically the tremendous amount of new gas available to the market will lead to one of two alternatives: either (1) creating a world-wide oversupply of gas or (2) causing a corresponding increase of demand to meet the massive supply. I believe the latter is a more realistic alternative due to the capitalistic nature of markets, governments, and corporations. Natural gas is becoming cheaper and more reliable than petroleum, so a capitalistic environment will obviously allocate the appropriate resources to stimulate demand. If this is the case, natural gas production could become one of the largest energy industries in the world in the next twenty years. In fact, according to ExxonMobil's Energy Outlook from January 2011, "Natural gas will be fastest growing major energy source, overtaking coal as the second-largest global energy source behind oil, and serving as a reliable, affordable and clean fuel for a wide variety of needs" (Exxon 1).

Large E&P corporations are not the only entities acknowledging the enormous potential of natural gas for our economy. In the May 2010 issue of the Oil & Gas Financial Journal, the magazine published a full editorial on the energy focused Investment Banking firm Tudor Pickering & Holt (TPH). Throughout the editorial many of the TPH executives note the importance of natural gas in the near future. David Pursell, Managing Director and Head of Macro Research at the firm, states "for much of the past decade, gas production could not grow, which put a stranglehold on demand growth…Over the long term, the combination of ample gas and cheap gas [vs. oil] should be a catalyst for meaningful US natural gas demand growth" (3). Among executives familiar with natural gas, there seems to be a reoccurring theme of natural gas demand growth (along with the ample supply) that the International Energy Agency is failing to acknowledge. Dan Pickering, Co-President and Head of Securities at TPH, notes some of the

current challenges for natural gas developments in the editorial; "It is the current low price. At $4-$5/mcf, the economics simply don't work for a meaningful portion of the industry" (4). Although gas prices are currently hovering right around $4, the demand increases that I have been referring to will inevitably drive up the price. With higher prices, E&P firms will be fully committed to drilling and developing all the workable reserves in our country. As a final point in the editorial, Mayndard Holt, Co-President and Head of E&P Investment Banking, states "Washington is acknowledging the value of natural gas as a leading energy source in the U.S., and operators recognize that now is the time to amass economic positions in this resource" (5). The editorial in its entirety is further evidence of the mutual recognition between industry and financial institutions on the tremendous opportunities that natural gas offers for the United States.

Along with the multitude of economic benefits created by this industry, natural gas also generates an opportunity rarely seen in the United States' energy markets: the possibility of exporting an energy source to other countries. The potential of export projects is a relatively young idea that has not gained much traction in the industry up to this point, but that could soon change. Cheniere Energy, a company originally established to operate natural gas receiving terminals in the Sabine Pass, is a perfect example of this transition. With the changing dynamics of the natural gas market due to the recent supply boosts, Cheniere Energy is beginning to transform into an export intensive operation. "Cheniere Energy, through its subsidiary Cheniere Energy Partners, L.P., has begun a project to add liquefaction to its Sabine Pass LNG receiving terminal in Cameron Parish, Louisiana. Earlier this year Cheniere received permission from the US Department of Energy to re-export imported LNG cargoes to a total of 500 billion cubic feet over two years" (Ausick 1). This company has decided to invest millions of dollars to make their

natural gas operations capable of receiving domestic natural gas through pipelines, liquefying it, and making it readily available for export to foreign nations. The capital costs tied to a transition of this magnitude are obviously large, signifying the company's belief in the potential of exporting natural gas. Additionally, Cheniere Energy is not the only company gearing up for export projects; many domestic firms are making the same kinds of capital commitments.

The speed at which the United States converted its' economic position in natural gas is breathtaking (almost ironic) and companies are racing to catch up; "That the US is likely to become a significant exporter of natural gas just a few years after it was expected to become a significant importer is quite a reversal" (Austick 2). As the possibility of exporting becomes more of a reality, this poses obvious benefits for the American economy; more specifically, stabilizing the Balance of Payments (BOP). The BOP is a measure of all monetary exchanges between a single country and the rest of the world, such as imports and exports, over a period of time. As you can imagine, the BOP figure for the United States is extremely heavy on the imports side of the equation. Natural gas exporting presents an opportunity for the United States to stabilize the BOP by keeping more money in the country and bringing in additional money from foreign nations. As I will discuss at a later point, this could simultaneously decrease the massive budget deficit that the United States has generated in recent decades.

Whether the benefits come from export projects, job creation or added value, natural gas has opened new doors for the direction of the United States' economy. Through the above analysis, I hope to have conveyed the scope of natural gas production and the corresponding impact on local communities and the overall country. But the analysis does not end there; for the United States to reap the full benefits of natural gas, many other contributing factors must fall into place.

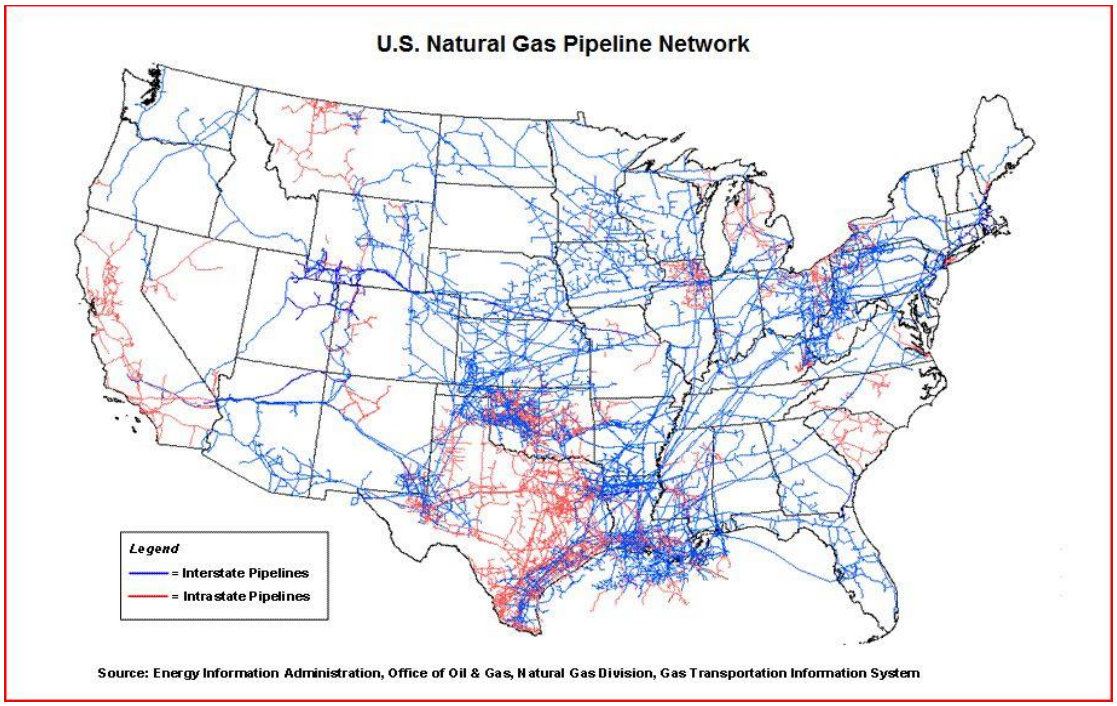
Developing the Appropriate Infrastructure for Stimulating Demand

All the potential growth of the natural gas industry in the next few decades depends on an appropriate infrastructure developing for both electricity generation and the transportation sector. The realization of an efficient and cost effective infrastructure is not far off the horizon. An extensive network of pipelines is already in existence to supplement the transportation of natural gas all around the country. With the existing infrastructure, a relatively modest amount of additional capital must be appropriated to fully support the increased use of gas in the next twenty years, more specifically, for the transportation sector. In this section of my analysis, I will address the amount of existing infrastructure already in place and I will also examine the amount of additional capital that must be invested in order to make increased consumption of natural gas viable for our country.

There are already a tremendous number of pipelines running throughout our country that currently supply natural gas to industry and residential consumers. According to the American Petroleum Institute, "over 95 percent of natural gas used in the United States moves from well to market entirely via a network of pipelines generally broken into three distinct systems: gathering systems that carry natural gas from individual wells for bulk processing at a treatment facility; transmission systems that carry the processed natural gas, often over long distances, from the producing region to local distribution systems around the country; and finally, local distribution systems that deliver natural gas into our homes, businesses and power plants." With such a massive system of pipeline in place, gas producers are able to transport their gas quickly and with low variable costs. In *Exhibit K* below, I have supplied a visual representation taken from the Energy Information Administration displaying the existing pipeline that carries natural gas all

over our country. Notice the congested areas of pipeline, such as the Gulf of Mexico region, Southeast Texas, and the quickly developing northeast region (Marcellus Shale activity). As the production of unconventional natural gas begins to pick up steam, this map is sure to have a lot more colored lines in the next few years.

Exhibit K



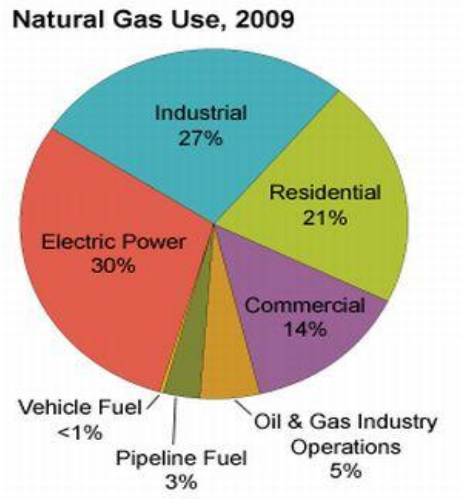
As you can tell from the map above, domestic corporations have already invested quite a large amount of capital into constructing natural gas pipelines. In order for these pipes to supply gas in an efficient and cost effective manner, an elaborate system has been devised. "Pipelines in the gathering and distribution systems range from 6 inches to 16 inches in diameter, with certain segments as narrow as ½ inch. The pipes making up the interstate transmission system range in diameter from 16 inches to 48 inches" (American Petroleum Institute). Although these systems are complex, they have demonstrated consistent reliability and move the gas from producers to consumers with relative ease. As the demand for gas rises, more pipelines will be developed to reach all the applicable consumers. Once you have come to appreciate the amount of pipeline

moving natural gas around our country, the question now becomes: where is all the natural gas going to be consumed?

Among the many applications of natural gas for energy consumption, there seems to be logical trends for electrical production and industrial use. Firms are beginning to move away from coal and towards natural gas for a number of reasons including relative cost and the lower carbon content. As James Herron notes in the aforementioned WSJ article, "Natural gas capacity is also considerably faster and cheaper to install than other new build sources of electricity" (2). For capitalistic firms looking to cut costs and be environmentally friendly, it is only logical to build a natural gas power plant as opposed to a coal facility. Not only would the initial capital costs be substantially less to build the physical plant, but firms would also cut their carbon emissions in half.

Although electricity generation and industrial use are currently the driving forces in demand for natural gas, there are a number of other applications that contribute to aggregate demand. In *Exhibit L* below, I have supplied a visual representation of the natural gas consumption patterns in 2009 taken from the Energy Information Administration.

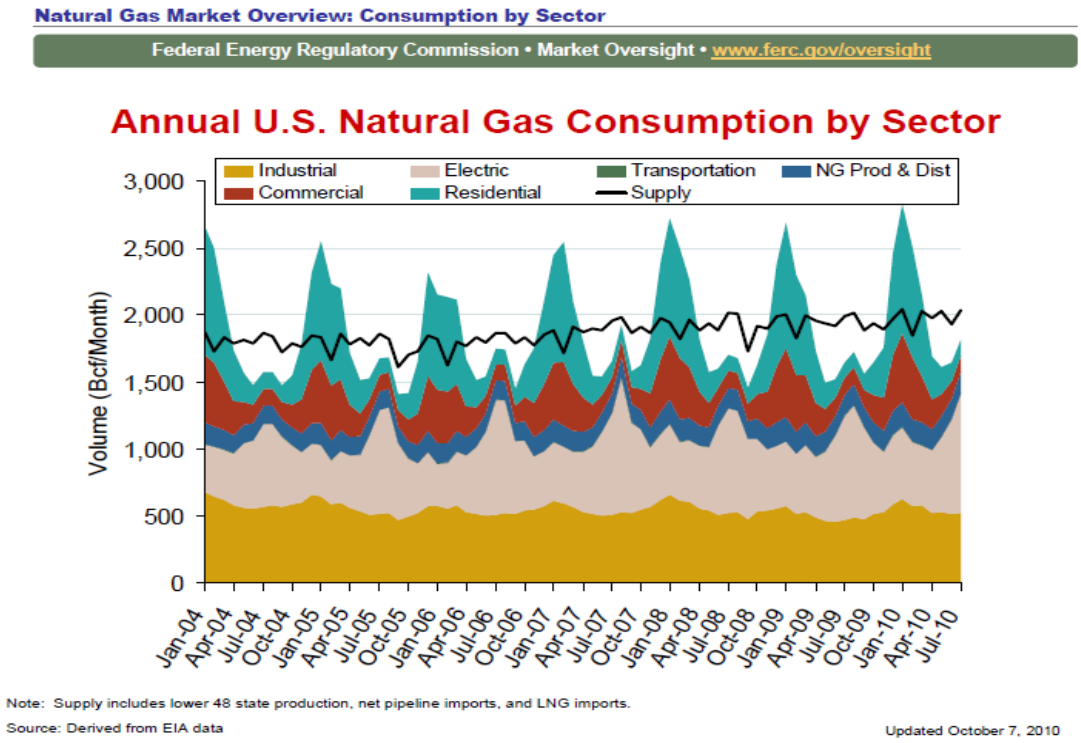
Exhibit L



Source: U.S. Energy Information Administration, *Natural Gas Monthly* (February 2010).

A slightly longer-term interpretation of similar data is displayed below in *Exhibit M*. As you may notice, the "Transportation" portion of the graph is not even large enough to be visibly evident. Additionally, the repetitive spikes in the graph are caused by the ordinary upswing of natural gas consumption for residential heating during the winter months.

Exhibit M



The above exhibits demonstrate the consistent impact on natural gas consumption from electricity generation, industrial use and residential heating. These three facets alone contribute to approximately 80% of overall gas consumption. Due to the recent discoveries of domestic natural gas and the underlying economics of natural gas power facilities, not only will the three big consumption factors increase their "slice of the pie", but the increasing demand will lead to a bigger overall "pie".

There is another element of *Exhibits L* and *M* that must not go unnoticed: the extremely small portion that is attributed to vehicle fuel. Over the course of the last few decades, the

United States has simply neglected the huge potential for natural gas in the transportation sector. In a 2009 article by Michael Fitzsimmons, he points out that "for a country that imports 65% of its oil from unfriendly foreign countries like Saudi Arabia, Russia, Iran, Iraq, and Venezuela one could consider this small usage of natural gas for transportation criminal neglect" (1). As a leader in technological innovation and a figure for economic authority, the United States undoubtedly has the capacity to develop an appropriate transportation infrastructure for natural gas. The lackluster use of natural gas in the transportation sector is not due to insufficient technology; in fact, suitable technology has been around for many years. Natural gas vehicles (commonly referred to as NGVs) first started appearing in the 1970s and have only become more efficient and cost effective in recent years. There are two types of natural gas vehicles with engines that either run on liquefied natural gas (LNG) or compressed natural gas (CNG). I will not delve into the specific production methods of these respective fuel types, but both methods are extremely refined and have comparable refueling logistics to gasoline. For example, it takes no longer to refuel a car with natural gas than it does with gasoline. According to NGV Global, "Natural gas can be used in all classes of vehicles - motorcycles, cars, vans, trucks, buses, lift trucks, locomotives, even ships and ferries. Natural gas can be used by either converting an existing gasoline or diesel engine, or by using a purpose built natural gas engine". With so many applications for natural gas as a means of transportation, the United States could literally transform the vehicle fleet in a relatively short period of time. A transition of this magnitude would not require car manufacturers to produce enough NGVs to replace entire vehicle fleet because gasoline vehicles can be converted. The cars that can currently be converted from gasoline to natural gas include the "Chevy Silverado, GMC Sierra, Ford Crown Victoria, Ford Grand Marquis, Ford Taurus, Lincoln Town Car, Ford F150, F250, E-350, E-450 and others"

(naturalgasvehicles.com). The need for massive production of NGVs is irrelevant because the aforementioned cars are among the most widely driven vehicles in the United States. Not only would a national initiative to increase natural gas vehicles create thousands of manufacturing jobs, but it would greatly decrease our dependence on foreign oil. This is a major topic in itself that I will discuss in a later section.

The United States is severely behind many countries who have converted a large portion of their vehicles to natural gas, such as Pakistan and Brazil. "There are about 110,000 NGVs on U.S. roads today and more than 12 million worldwide" (NGV America). These figures translate to a dismal statistic; the United States employs less than 1% of the world-wide natural gas vehicles currently on the road. Even more discerning, the three largest users of NGVs are Pakistan, Argentina, and Brazil. Obviously these countries are far less technologically and economically secure than the United States; so why are they so far ahead with their use of NGVs? The answer lies in the inability, or neglect, to establish a long-term domestic energy policy. In one man's opinion, "The biggest policy failure in American history is not adopting a strategic long-term comprehensive energy policy in the face of importation of 65% of our oil, fighting oil wars, and going bankrupt in the process" (Fitzsimmons 1). Unfortunately the United States was not blessed with enough domestic petroleum to sustain the country's growing needs. This has caused the United States to import approximately 65% -70% of our petroleum; "in 2008 alone, the U.S. spent $475 billion on imported oil" (Pickens). The United States is in dire need of a transportation revolution, both economically and politically. Natural gas vehicles in conjunction with our tremendous amount of shale gas give the United States the unique opportunity to transform the domestic transportation sector.

Although the United States is substantially behind other countries in terms of natural gas vehicles employed on the roads, there has been some progress made on developing an infrastructure for transportation. According to NGV America, "There are about 1,000 NGV fueling stations in the U.S. – and about half of them are open to the public. Additionally, there are about 30 different manufacturers that produce 100 models of light, medium and heavy-duty vehicles and engines." These figures demonstrate that there has been some commitment by domestic corporations to facilitate greater use of natural gas in the transportation sector. Although this is somewhat encouraging, the United States still has a long way to go. Most of the demand is derived from public forms of transportation and commercial vehicles; very few consumer NGVs are in the market. "Transit buses now account for about 66% of all vehicular natural gas use" (NGV America). In fact, the bus line that services Penn State University, Cata Bus, operates all of its vehicles on natural gas and has done so for years. "In 1993 CATA took steps to go 'green' and by 2005 became the first transportation agency on the East Coast to have replaced its entire fleet with one that operates solely on clean compressed natural gas" (catabus.com). Commercial vehicle fleets running on natural gas are much more prevalent in today's market because they return to a central location at night, which makes the refueling process seemingly effortless.

The major factor impeding the use of NGVs for the general consumer is the lack of refueling stations needed for the daily commute. The average American does not have the luxury of returning their car to a refueling station at night like mass transit vehicles have. Although this is a problem for companies trying to sell NGVs and a deterrent for consumers looking to purchase, there are solutions being developed that will revolutionize the natural gas vehicle market. There are roughly 1,000 refueling stations available for NGVs and this number is

quickly escalating. Even with this considerable amount of growth, 1,000 NGV refueling stations must be compared to approximately 175,000 gasoline stations, so natural gas has some catching up to do. "As consumers demand more CNG vehicles, America's refueling infrastructure (both private and public fueling sites) will quickly grow to meet that demand – particularly with greater emphasis on federal incentives for fuel retailers, as well as automakers and consumers" (CNGnow.com). California alone already has 129 NGV fueling stations available to consumers, but they are far ahead of other states; Oklahoma is second with 31 stations and New York is a close third with 29. With increasing demand and the possibility of federal incentives, it is only a matter of time before all fifty states begin to implement these NGV facilities in greater abundance.

It is also important to note that there is no need for an entirely new station to be built in order to supply natural gas; existing gasoline facilities must simply have access to a gas pipeline and construct the accompanying pumping stations to adequately supply consumers. "Public refueling stations are usually supplied either by piped natural gas (just like at home), or by 'tube trailers'. A station supplied by a tube trailer is part of a 'mother-daughter' system, where the fuel is compressed at the mother station and delivered via the tube trailer to the daughter station. Mother-daughter systems are usually used when piped natural gas is not available" (NGVGlobal). Gasoline fueling stations around the country could quickly be refitted to accommodate NGVs due to the prevalence of gas pipelines in nearly every corner of the United States; "There are approximately 1.5 million miles of gas pipe and distribution lines crisscrossing the country, making natural gas available on nearly every street and community in America today" (Pickens). Additionally, the similarities in fueling procedures for gasoline and natural gas

make the learning curve for consumers almost negligible, allowing the transition process to be less daunting.

Before the infrastructure for refueling stations begins to be implemented nationwide, there are other alternatives for NGV refueling. Recently companies have begun to develop home refueling stations that are easily installed in a standard American home. The entire system contains a floor or wall mounted unit installed in a garage or outside that is connected to the same gas line that supplies gas for heating or the stove-top. "The main advantages of home refueling are convenience and low cost. With home refueling, you not only avoid the hassle of having to visit a service station for fuel, but you also have the convenience of paying for your fuel along with your home or business natural gas bill" (NGVGlobal). After installing such a system, the upfront costs are quickly reclaimed due to the lower cost of natural gas compared to gasoline; "in many cases, vehicles fueled up at favorable natural gas home rates can operate as cheaply as the equivalent of $1.25 to $1.50 per gallon" (naturalgasvehicles.com). With gasoline prices inching towards $4 per gallon in our current economy, consumers would undoubtedly welcome the lower relative price of natural gas.

Home fueling is not a fantasy conjured up by some eco-friendly organization; in fact, Honda has recently unveiled the *Phill* home refueling appliance. This device can easily be mounted in a garage or outdoors and is connected to the same gas system as the rest of the home. The *Phill* will "take approximately 4 hours to replenish the fuel consumed in 80 km / 50 miles of driving based on a vehicle consumption rate of 30 mpg. And at 800 watts, *Phill* uses less electricity than most small kitchen appliances" (wisegasinc). Basically, the *Phill* is most effective when plugged into the car overnight, allowing enough time to fill the car to capacity in a safe manner. "When your vehicle is not is use (ideally overnight) you simply plug *Phill* in to your

car, press ‘Start’ and *Phill* will do the rest! When your tank is full, *Phill* will safely shut itself off for you.” (wisegasinc). In *Exhibit N* below, I have included a picture of the *Phill* along with an additional image to demonstrate the size requirements.

Exhibit N

Although home refueling is a recent development and a foreign concept for most American consumers, I believe it has the potential to spread into homes all over the country. Once consumers become accustomed to refueling vehicles at home as opposed to a gas station, the convenience and lower cost will make home refueling a very popular alternative.

The expanding number of NGV compatible fueling stations coupled with the development of home fueling technology creates an opportunity for the United States to convert a substantial portion of vehicles to natural gas. The progress of this developing infrastructure has been inadequate to facilitate substantial demand for natural gas. Consumers are simply not confident enough with the current infrastructure to purchase NGVs on a large scale. As noted earlier, the government has also been severely lacking in developing an appropriate long term energy plan for the country’s future. In order for a sufficient natural gas infrastructure to be employed, both federal and state governments must begin to offer more incentives for the

manufacturing of natural gas vehicles and stations along with policies to stimulate consumer demand. For a federal government that has seemed complacent to the fact that we import approximately 65% of our petroleum from foreign countries, it is time for a change. There are a host of different policies the federal and state governments could implement in order to spur infrastructure development. These policies include "mandates, favorable fuel taxes and excises, technology support, direct funding, leading by example, and preferential benefits" (NGVGlobal). Each of these policies would directly stimulate the production of a natural gas infrastructure almost immediately. Additionally, it is important to understand that individual states, along with the federal government, also have the power to "adopt incentives to encourage CNG retailers to expand and add more stations nationwide" (CNGnow).

In order to demonstrate the effect of such measures, I will analyze a number of the aforementioned policies in greater depth. First, mandates are not a popular form of federal policy due to their authoritative nature, but they are certainly effective. The United States' government has the ability to implement mandates on vehicle owners and energy suppliers alike, requiring certain standards for natural gas use. Although the federal government has been hesitant to issue such mandates, foreign governments seem more akin to using mandates and these policies have been effective for the implementation of natural gas; "probably the most widely known example of a mandate in the NGV industry is the public bus system Delhi, India, which is required to use compressed natural gas. This has resulted in more than 10,000 CNG buses on Delhi's roads and has been credited with making significant improvements to Delhi's air quality" (NGVGlobal). Mandates can also be issued below the federal level, such as California's state government requiring a certain portion of vehicle fleet operators to use NGVs. Although mandates have the

potential to cause social unrest amongst the parties affected, this type of policy is the most direct way to stimulate infrastructure growth for the natural gas industry.

Another direct method for effectively stimulating natural gas demand and infrastructure growth is for governments to dictate the energy supply through “tax and fuel excise schemes; these provide an opportunity for government to favor natural gas as a transport fuel, either through reduced rates or by increasing rates for status quo fuels such as gasoline or diesel. These provide a direct fuel cost benefit to end users, which can be used to offset any extra costs associated with NGVs or to offset any perceived 'risk' of adopting a fuel which may have relatively limited availability” (NGVGlobal). If the federal government were to implement a tax policy increasing the tax rates on gasoline and decreasing the rates on natural gas, consumers would be incentivized to either convert their cars to natural gas or to purchase an NGV. Corporations and intermediate retailers would also benefit from tax breaks and respond with increased development of natural gas facilities, which would broaden the transportation infrastructure.

The next two policy alternatives mentioned by NGV Global go hand-in-hand; technology support and direct funding. Due to the fact that natural gas technology is relatively pricey at this point in time, the national and state governments could either issue “direct grants or tax concessions for product development, emissions testing or compliance and homologation costs. This lowers costs and risks for the manufacturer” (NGVGlobal). Through these policies, corporations could begin to benefit from expanding the number of fueling stations available to the public. Either of these methods would also lead to further technological development by corporations, which in turn would lead to greater efficiency and lower costs for the consumers. Governments can also stimulate demand for NGVs by “providing grants or rebates to purchasers

of natural gas vehicles or conversion systems, effectively offsetting the additional costs incurred by the vehicle owner" (NGVGlobal). With direct grants or rebates, the slightly more expensive prices of NGVs can be nullified, putting both types of vehicles on an even playing field for the American consumer.

The final government initiative that I am going to touch on is not a conventional "policy" in the sense of the word, such as favorable taxes or direct funding. NGV Global refers to this policy as "Leading by Example" and I believe it is more of a commitment than an actual policy. The website references the large portion of vehicle purchases conducted by the government and points out that "committing to use alternative fuels can have a significant influence on making natural gas vehicles available in the market place. As well as making purchases directly, additional influence can be applied by requiring government contractors to provide services using natural gas vehicles as well" (NGVGlobal). The federal government is obviously one of the largest consumers of multi-purpose vehicles in our country, so a commitment to convert their vehicle purchases to NGVs would immediately stimulate aggregate demand. Not only would this type of policy generate substantial new consumption patterns, but it would also indirectly produce consumer confidence in the market for NGVs. The average American consumer would most likely feel more secure purchasing an NGV if the federal government has deemed them worthy enough for its' own personal use. Basically, this type of commitment would stimulate demand through two channels, direct federal purchases and increased consumer confidence in the overall market for NGVs.

Although the federal government has been hesitant to install policies for transportation and infrastructure growth in recent years, the natural gas market has been the focus of many other policy initiatives for decades. During the late 1970s, the United States was in the midst of

massive supply shortages of natural gas due to federal regulation of market prices. The Natural Gas Policy Act (NGPA) of 1978 began the deregulation of the natural gas market by setting maximum lawful prices, as opposed to actually setting the market price. "Essentially, this act had three main goals: creating a single national natural gas market, equalizing supply with demand, and allowing market forces to establish the wellhead price of natural gas" (naturalgas.org). The NGPA provided new economic incentives for producers who had been previously disinterested due to the regulated prices. "The market response to the provisions of the NGPA included: pipelines, accustomed to gas shortages in the past years, signed up for many long-term natural gas contracts; producers expanded exploration and production; drilling new wells; average wellhead prices rose dramatically; prices for end-users increased, but were mitigated by the pipelines; and finally, prices increases led to decreased demand" (naturalgas.org). The result of this policy was exactly as the government had intended, ending the natural gas supply shortages by ultimately increasing prices and decreasing demand. Unfortunately, the NGPA generated too much action by producers and simultaneously raised prices to the point where consumers were not demanding enough. These factors, when taken in unison, actually led to an oversupply of natural gas on the market; the exact opposite ends of the spectrum from where the country had begun.

We have come a long way from the regulated natural gas market of the 1970s, but I still believe in the need for government incentives to spark growth in the natural gas industry. Although the aim of the Natural Gas Policy Act was directed at circumstances entirely different from what the country is facing today, the overall theme of government intervention in the natural gas markets is certainly applicable. To reiterate one of the goals of the NGPA, the government was focused on "equalizing supply with demand". I find this aspiration very relevant

to the natural gas markets in today's world and I believe the government should take a similar stance with regards to supply and demand. The United States currently has enough natural gas to supply the nation for a number of decades, although few steps are being taken to increase domestic demand to the point of matching supply. Policy initiatives, similar to the ones previously mentioned, must be implemented to incentivize domestic industries to manufacture NGVs, fund other necessary infrastructure changes and to guide consumers towards NGVs. Even the Department of the Interior acknowledges the fact that "America exports hundreds of billions of dollars each year to buy the oil we need to power our country. Our dependence on foreign oil threatens our national security, our environment and our economy". As I will discuss in the following section, I believe that domestic natural gas is the best way to begin eliminating our dependence on foreign oil. I also strongly believe that not enough is being done by the government to stimulate the appropriate demand. In terms of developing our natural gas resources, the Department of the Interior states "As we move our nation toward a clean-energy future, we will use sound science, wise policies, and the input of the public to determine how and where to develop these resources". Although this politically correct statement sounds fine in theory, simply not enough progress is being made.

The federal government seems content to pump resources and money into renewable energy projects such as wind, solar, and geothermal in much greater abundance than they do for natural gas. With regards to solar power, "The Bureau of Land Management manages 30 million acres of public lands with solar potential. We have set aside 1,000 square miles of BLM lands in 24 solar-energy study areas" (Department of the Interior). Even greater resources are injected into developing wind and waves, "Onshore, our BLM manages 20.6 million acres of the lands that hold the potential to generate wind power. Offshore, the Minerals Management Service

manages the Outer Continental Shelf, 1.7 billion acres of federal-offshore lands with enormous wind potential. MMS has granted the first-ever exploratory leases for wind-energy production on the OCs and has established a framework for offshore renewable energy development" (Department of the Interior). The amount of money spent to develop these millions of acres and issue such grants is almost unimaginable. President Barak Obama preached the benefits of clean energy in his January State of the Union Address, citing the environmental benefits of wind and solar programs. Unfortunately these types of programs have enormous capital costs tied to them, making them an expensive long term solution. In the shorter term, policy initiatives by the federal government could have profound effects on the demand for natural gas, which would stimulate the economy while still cutting carbon emissions in half. It is also worth stating that I am not trying to debase the efforts by the federal government to facilitate greater research into renewable energy projects such as wind and solar; I am merely suggesting that the government should pay more serious attention to the potential of natural gas along with these other forms of energy (and I am not the only person who feels this way). Jim Cramer, the host of CNBC's "Mad Money" and a respected voice in the financial world, seems to have similar feelings. In the February 24th taping of his show, he stated "The need for natural gas in the U.S. has become obvious with the Libyan turmoil. As obvious as this theme is to Wall Street, it's totally off the minds of the oblivious Congressmen and perhaps the President" (Cramer). While I do not endorse Mr. Cramer's opinions on certain political figures, I do strongly corroborate his views on natural gas. He went on to compare the underlying economics of natural gas to petroleum, "The price stability of this fuel, vs. oil, is such a wonder. Somebody has to take notice in Washington" (Cramer). Although Mr. Cramer is certainly not subtle about voicing his opinions on Congress or

the President, he raises legitimate concerns about the government's energy agenda, or lack thereof.

The federal government must appropriate an equivalent portion of funding for developing a fully functional natural gas infrastructure for the transportation sector. Direct grants and tax concessions for product and infrastructure development would go a long way in generating a channel for increased natural gas demand. Tax and fuel excise schemes would also make NGVs more economical for the average consumer, leading to far greater natural gas consumption in the transportation market. The following statement conveys this point very succinctly, "The bottom line is simple. We need more major automakers manufacturing new CNG vehicles at home and more American consumers taking them to the streets" (CNGnow). Overall, commitments must be made by federal and state governments, along with corporations, aimed at developing an improved infrastructure for natural gas. If the United States bands together to create such an infrastructure, demand will inevitably rise to meet our enormous supply of natural gas which will create jobs and redistribute the billions of dollars that we ship to foreign nations for their oil. If this can be accomplished, the goal of The Natural Gas Policy Act of 1978 will once again come to fruition, "equalizing supply with demand".

Decreasing Dependence on Foreign Oil

Throughout the analysis to this point, I hope to have conveyed some appreciation for the scope of natural gas' potential economic impact and the need for developing a more suitable infrastructure. With the appropriate level of commitment from domestic corporations and government, I believe that natural gas will create thousands of jobs and have a multitude of beneficial economic impacts. As noted in the previous section, converting some portion of America's vehicle fleet to natural gas would not only create jobs in the process, but it would also begin to eliminate our dependence on foreign oil. This would be advantageous on many levels; primarily redirecting the billions of dollars we send to foreign countries for their oil and alternatively investing it in domestic companies involved in the production and distribution of natural gas. Secondly, the United States could greatly diminish the inherent risk exposure to unstable foreign nations and minimize the macro impacts of fluctuating oil prices on our economy. In this final section of my analysis, I hope to bring all the beneficial aspects of natural gas into one concise goal: decreasing our dependence on foreign oil by increasing production and consumption of domestic natural gas.

Although I cited this quote from the Department of the Interior at an earlier point, it is worth reiterating; "America exports hundreds of billions of dollars each year to buy the oil we need to power our country. Our dependence on foreign oil threatens our national security, our environment and our economy." I find it unsettling that our own government acknowledges the country's dependence on foreign oil yet still does very little to combat the situation. It is a well documented fact that the countries who we import the majority of our oil from are far less than stable (to say the least). At the very moment I am writing this, turmoil in the Middle East and

Africa has migrated from Egypt to Libya and it will most likely not stop there. Political and social unrest has exploded in Libya due to the unjustified and corrupt reign of Moammar Gadhafi, the nation's leader for 42 years. According to a recent CNN article by Mike Pearson, "U.S. leaders initially tried working with Gadhafi, it quickly became clear he was an Arab nationalist and relations with the West quickly deteriorated" (1). Obviously the United States attempts to keep peaceful relations with countries we import oil from, although as this quote suggests, keeping the peace can be nearly impossible at times.

The unrest in Libya has escalated to violence, which "knocked out at least half the country's production, according to industry executives" (Farchy 1). This translates to at least 700,000 barrels of daily oil production being halted entirely. This caused an enormous supply shock and the price of oil increased to nearly $99, a $6 increase in a single day. Oil futures hit $100 a barrel in February 2011 for the first time since October 2008. Amrita Sen, an energy analyst for Barclays Capital, was quoted in a CNN article stating, "The overall significance of the situation is more than just about lost barrels. Destabilization in the Arab world, home to the world's largest oil and gas reserves and production, is of extreme significance" (Farchy 1). Even though the United States does not directly import any petroleum from Libya, the price increases are felt by every American consumer as they pull up to the gas pump. In a similar article by Grant Smith of Bloomberg, his views on the Libya situation are even more pessimistic; "Oil prices may surge to $220 a barrel if political unrest in North Africa halts exports from Libya and Algeria" (Smith 1). Additionally, Libya only ranks 17th on the list of major oil exporters; it seems alarming that Libya's decrease in production caused the price of oil to rise $6 in a single day. This $6 increase equates to the price of oil jumping up 6.45% in a 24 hour period. Based on the fact that the United States spent $475 billion on oil in 2008, the same 6.45% increase

annualizes to nearly $31 billion more dollars being spent by American consumers to fill up their gas tanks. Could you imagine what would happen to the price of oil if similar situations arose in more major oil exporting countries, such as Saudi Arabia or Iran?

Supply shocks similar to the Libyan situation have been a reoccurring theme for many of the nations who export oil to the United States. In fact, the Organization of Arab Petroleum Exporting Countries (OAPEC) declared an oil embargo on the United States in 1973. This proclamation was a result of the United States' decision to aid the Israeli military during the Yom Kippur war. This decision and the subsequent embargo caused the famous "1973 oil crisis". As a retaliatory measure to the entire state of affairs, OAPEC members decided to use their production leverage to raise world oil prices. These higher prices reverberated throughout the United States and caused the economy to stall and the stock market to crash; this situation was a major contributor to the 1970s recession.

The Libyan turmoil and the 1973 oil crisis are just two of the numerous foreign events that have had drastic impacts on the United States' economy. Based on the economic outcomes of such affairs, the United States seems far too negatively impacted by chaos in foreign nations. For the price of oil to rise $6 in a single day due to violence in a foreign country that ranks 17th in petroleum exports and does not even export oil to the United States, the risk exposure is simply too great for our country to maintain the status quo. Natural gas has given the United States the opportunity to alienate itself from foreign risk exposures and the corresponding volatility of oil prices. Put succinctly, "The need for natural gas in the U.S. has become obvious with the Libyan turmoil" (Cramer). The federal government must take steps to decrease our foreign oil dependence, thereby reducing the macroeconomic effects of supply shocks and

keeping more money in consumer's pockets. In the analysis that follows, I will convey the fact that the most efficient and cost effective way to accomplish this goal will be through converting a portion of America's vehicle fleet to natural gas.

The push for energy independence has been publicized by the media in recent years, most notably by T. Boone Pickens, the chairman of BP Capital and noted energy activist. Mr. Pickens released his own personal blueprint for energy independence called "The Pickens Plan", which has gained notoriety in the energy world. The plan's website, pickensplan.com, portrays our energy dependence as addictive in nature; "It's an addiction that threatens our economy, our environment and our national security. It touches every part of our daily lives and ties our hands as a nation and as a people. The addiction has worsened for decades and now it's reached a point of crisis" (Pickens). The website goes on to put this addiction into quantitative terms; "In addition to putting our security in the hands of potentially unfriendly and unstable foreign nations, we spent $475 billion on foreign oil in 2008 alone. That's money taken out of our economy and sent to foreign nations, and it will continue to drain the life from our economy for as long as we fail to stop the bleeding. Projected over the next 10 years the cost will be $10 trillion - it will be the greatest transfer of wealth in the history of mankind" (Pickens). Although devastatingly pessimistic in nature, these comments portray our oil dependence with complete accuracy. The United States has been stimulating our oil addiction by throwing more money at the problem for decades on end. "In 1970, we imported 24% of our oil. Today, it's more than 65% and growing" (Pickens). As opposed to implementing a long-term energy plan to cut down on our petroleum imports, the federal government has simply decided to continue shipping money to foreign nations, accumulating a massive budget deficit in the process. It's hard to comprehend the amount of money we have sent to foreign nations to feed our oil addiction.

The Pickens Plan is a starting point for strategically cutting down on petroleum imports and creating an energy independent America, something that hasn't ever been accomplished. Within this plan he calls for greater electricity generation from wind power and comments on the potential of other renewable energy sources, but the driving force behind his vision lies with natural gas. On the Pickens Plan website, they suggest "by aggressively moving to shift America's car, light duty and heavy truck fleets from imported gasoline and diesel to domestic natural gas we can lower our need for foreign oil - helping President Obama reach his goal of zero oil imports from the Middle East within ten years" (Pickens). As I have stated time and time again, this goal will require government and corporations working in unison to set forth an appropriate roadmap for the future. By targeting specific areas of the transportation sector, the transformation from gasoline to natural gas could be fast and cost effective, while sacrificing no productivity in the process. The most obvious targets for conversion to natural gas are the fleet trucks that move goods across the country. "Nearly 33% of every barrel of oil we import is used by 18-wheelers moving goods around and across the country by burning imported diesel" (Pickens). Because these trucks maintain fairly stable travel patterns, natural gas fueling stations could be easily installed on highways to fuel these vehicles.

If the United States is able to develop an organized transition process for converting all 18-wheelers to natural gas, we could begin cutting out oil imports from the most unstable nations. In *Exhibit O* below, I have created a chart that displays a comprehensive list of countries exporting petroleum to the United States in order from largest percentage to smallest. These figures are from 2009.

Exhibit O

Total Imports of Petroleum (Top 15 Countries)
(Thousand Barrels per Day)

Country	May-10	%
Canada	2,527	24%
Mexico	1,428	13%
Venezuela	1,109	10%
Saudi Arabia	1,097	10%
Nigeria	1,026	10%
Russia	719	7%
Algeria	518	5%
Angola	448	4%
Iraq	394	4%
Brazil	320	3%
Colombia	315	3%
Kuwait	225	2%
Virgin Islands	193	2%
United Kingdom	176	2%
Ecuador	160	2%
Total	10,655	100%

As of 2009, approximately 37% of our country's petroleum imports came from Canada and Mexico. Historically the United States has had very secure relationships with these two bordering countries and both nations have relatively stable economies. When taking the first steps towards energy independence through eliminating problematic exporting nations, these two countries should be fairly low on the priority list. By contrast, the three countries that I have highlighted in red are a different story all together. Venezuela, Saudi Arabia and Nigeria have all experienced some type of turmoil in recent decades, stemming from political unrest, foreign relations, religious strife, or civil war. While all these nations currently have neutral relations with the United States, unforeseen circumstances could soon cause these associations to deteriorate. Each of these countries accounts for approximately 10% of our petroleum imports respectively, for an overall total of 30%. If you will recall, T Boone Pickens derived the fact that 33% of the oil that we import goes to fueling the trucking fleet. If the United States were able to convert all the 18-wheelers to natural gas, we could fully eliminate petroleum imports from

Venezuela, Saudi Arabia and Nigeria. For America's future to one day be free of foreign oil, I view this strategy as the most logical first step.

Eliminating 30% of our petroleum imports approximates to $140 billion[1] per year being kept in the United States as opposed to being sent to foreign nations. Reinvesting this money in our own economy could be used to cut down on the massive budget deficit, which is projected to reach $1.5 trillion in 2011. In his recent State of the Union Address, President Obama touched on this very topic, proposing a freeze on all discretionary spending in order to save $250 billion over the next three years. As opposed to freezing discretionary spending, eliminating 30% of our foreign oil imports through natural gas initiatives could have even greater monetary effects and would be a much longer-term solution. Along with easing the strain on our national budget, the additional money generated from eliminating foreign oil could be used to finance other energy projects; "Natural gas is the critical puzzle piece that will help us to keep more of the $350 to $450 billion we spend on imported oil every year at home, where it can power our economy and pay for our investments in wind energy, a smart grid and energy efficiency" (Pickens). This type of alternative energy funding is also in line with President Obama's energy agenda, but natural gas could ease the financial burden without escalating taxes on the American consumer. With the appropriate endorsement by the federal government, natural gas consumption can be the catalyst for energy independence while cutting down the budget deficit and stimulating other clean energies in the process.

Although the federal government has been slow to embrace the potential of natural gas, the same cannot be said for a number of domestic corporations. "Waste Management today

[1] Estimates place $475 billion per year spent on foreign oil by American consumers. 30% of this figure translates to $140 billion per year.

officially broke ground on its new compressed natural gas (CNG) fueling station at its South Seattle operations headquarters and also unveiled the region's most environmentally advanced, solid waste collection trucks. The new trucks are fueled by CNG and will dramatically lower greenhouse gas emissions" (Salinas). This press release from Waste Management acknowledges the environmental benefits of switching its collection trucks to natural gas, but I believe they will also enjoy cost advantages in the future. Once the initial capital outlays are appropriated to build an infrastructure, natural gas has a comparative price advantage to oil, which is somewhere in the range of $1.50 per gallon of oil equivalent at current price levels. As an additional benefit, natural gas is also a cleaner burning fuel than oil so the long-term maintenance costs to keep vehicles running are significantly lower.

Other companies, such as AT&T, are also beginning to invest in natural gas vehicles, signaling that this is not an isolated phenomenon; "We recently announced plans to invest more than $350 million to purchase about 8,000 Compressed Natural Gas vans from Ford Motor Company" (AT&T). This recent investment by AT&T is a prime example of the multi-level benefits for the United States economy. Developing their own infrastructure of NGVs increased business for another domestic company, Ford Motors, and also instilled confidence in consumers. These two companies, Waste Management and AT&T, are literally "leading by example" and paving the way for America to reach energy independence. As the benefits of natural gas become more widely endorsed, more and more domestic firms are investing capital into natural gas vehicles and infrastructure developments. I believe this trend will only pick up speed if the government begins subsidy programs and issues tax breaks for natural gas technologies.

At this point, it should be fairly apparent that there are a multitude of strategies to insert natural gas into the American transportation market. The goal of the Pickens Plan, to convert the tucking fleet to natural gas, is both practical and cost effective. Natural gas fueling stations can be placed along the interstate highways at existing gas stations by simply connecting to a natural gas pipeline. Additionally, domestic firms are already beginning to switch their vehicles to natural gas, signaling that the energy tide is beginning to shift. If this commitment can be replicated on a larger scale by more American firms, the added benefit to the United States' economy will be substantial. With these two initiatives, converting the overall trucking fleet and domestic firm's vehicle fleets to natural gas, the country would be taking a tremendous first-step towards energy independence. These two strategies in unison could yield upwards of a 40% reduction in foreign oil imports and allow the country to pick and choose what foreign countries to discontinue importing from, a luxury that the nation has never before experienced.

Conclusion

Through the analysis conducted in this study, I hope to have conveyed an appreciation for the potential impacts of natural gas on the United States' economy. Although this industry has been in existence for many decades, the true scope of natural gas production has only recently been unleashed. The transformation of the domestic natural gas market has been a culmination of many correlated factors coming together in perfect unison. The enormous reserves of shale gas combined with the appropriate technologies ushered in new opportunities for the United States. As laid out in the above analysis, these opportunities can be parlayed into numerous economic benefits and overall energy stability. Whether the benefits come from increased job production,

added value to the economy, export projects, or decreased dependence on foreign oil, natural gas offers a realistic path towards a new era of energy.

Domestic corporations, financial institutions, and academia are embracing natural gas as a viable alternative for the future of America's energy needs. With the support of federal, state, and local governments, this industry could be fully implemented into the American market place quickly and efficiently. The existing infrastructure gives natural gas a leg-up on other alternative energy sources and this advantage should be exploited to the fullest. The expansive network of pipelines makes natural gas available to nearly all domestic markets; which allows for the wide-spread entry of natural gas into the transportation sector. With increased use of natural gas to power vehicles, the United States can begin to alleviate the need for foreign oil. This will keep billions of dollars in the country and greatly diminish risk exposure to unstable nations.

Even with the enormous potential of natural gas and the obvious benefits of increased domestic production, this energy source seems to receive relatively minor amounts of media exposure; although this is beginning to change. While in the process of finalizing this thesis, a very prominent magazine happened to publish a timely article praising the natural gas industry. *Time Magazine* dedicated the April 11th, 2011 cover story to natural gas, which was titled "This Rock Could Power the World: Why Shale Can Solve the Energy Crisis." The story was written by Bryan Walsh and touches on many of the same issues present in the above analysis; "gas will change geopolitics, trimming the power of states in the troubled Middle East by reducing the demand for their oil; save the lives of thousands of people who would otherwise die from mining coal or breathings its filthy residue; and makes it a little easier to handle the challenges of climate change- all thanks to vast new onshore deposits of what is called shale gas" (Walsh 42). I found the convenient timing of this article to be further evidence for the legitimacy of my views

on natural gas; it was also very gratifying to see the focus of my work published on the cover of *Time Magazine*.

Similarly convenient in terms of timing, President Obama also happened to praise the natural gas industry shortly before the close of my work on this thesis; "In a speech on March 30, 2011, President Barack Obama hailed natural gas as part of the solution to reducing America's oil addiction. 'The potential for natural gas is enormous,' he said" (Walsh 42). As I have touched on numerous times, the need for government support is of paramount importance for fully harnessing our natural gas reserves. Based on the words of the President, it seems as though this support is beginning to come to fruition. With the endorsement of the President and stronger media coverage, it is only a matter of time before natural gas production gains more traction in our national energy picture.

In summation, the increased production and consumption of unconventional natural gas is beneficial on almost every front imaginable. My analysis was laid out in a logical order to demonstrate the full potential of natural gas and the corresponding steps that must be taken to stimulate demand. For the first time in the history of our nation, we have an energy source that can be fully produced within our borders and be consumed by our citizens. With enough reserves to supply the country's needs for the next century, natural gas offers a path towards eventual energy independence that must be seized. For a nation desperately in need of a long-term energy strategy, natural gas is the most logical first step for creating a stable energy environment while simultaneously stimulating the national economy for decades into the future.

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Appendix 1

Year	*1% Growth*	*3% Growth*	*5% Growth*
2010	$ 4,000,000	$ 4,000,000	$ 4,000,000
2011	4,040,000	4,120,000	4,200,000
2012	4,080,400	4,243,600	4,410,000
2013	4,121,204	4,370,908	4,630,500
2014	4,162,416	4,502,035	4,862,025
2015	4,204,040	4,637,096	5,105,126
2016	4,246,081	4,776,209	5,360,383
2017	4,288,541	4,919,495	5,628,402
2018	4,331,427	5,067,080	5,909,822
2019	4,374,741	5,219,093	6,205,313
2020	4,418,489	5,375,666	6,515,579

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Education

The Pennsylvania State University: The Smeal College of Business
University Park, PA
Schreyer Honors Scholar
Class of 2011

- Candidate for Bachelor of Science in Finance
- Honors Thesis- "Unconventional Natural Gas: An Economic Driver for the United States Economy"
    - Documents and analyzes the potential economic and social impacts of the developing U.S. Natural Gas shale plays into the near future

Experience

SCF Partners
Houston, TX
Private Equity Intern June 2010-August 2010

- Responsible for the evaluation and execution of new investment opportunities and support of ongoing portfolio company initiatives
- Developed financial models supporting portfolio companies' merger and acquisition activities. Valuation models included Public Comps, Discounted Cash Flow, Merger Consequence, etc.
- Created and presented investment overviews for potential new investment opportunities
- Performed reconciliations on privately held portfolio companies' reported financials to audited financials

National Oilwell Varco, Inc.
Houston, TX
Finance Intern- Internal Audit June 2009- August 2009

- Conducted SOX 404(c) internal financial controls testing for multiple facilities
- Created and executed an entire Fixed Assets Audit
- Traveled to several major manufacturing facilities to perform financial audits and perform inventory cycle counts. Locations included a top-drive manufacturing facility in Orange County, California and a drill pipe manufacturing facility in College Station, Texas.

National Oilwell Varco, Inc.
Houston, TX
Finance Intern- Treasury Department June 2008- August 2008

- Developed a comprehensive data base for the presentation of daily global bank account data
- Organized and streamlined a number of Excel-based data files that dealt with various bank accounts

Leadership

Beta Theta Pi Fraternity
University Park, PA
Financial Vice President August 2008- May 2009

- Elected by peers to organize and manage a $200,000 budget for the active members
- Developed payment plans and monetary aid for under-privileged members
- Worked with the Fraternity Payment Association to organize whole-sale payments

Kai Committee (Internal governing body for fraternity)

- Elected by peers to maintain order and establish rules
- Dealt with potentially sensitive issues and communicated with the active alumni base

High School Achievements

Academic All-State Award for Golf
Houston, TX

- Awarded for outstanding academic and athletic performance in the state of Texas
  May 2007
- Four years of Varsity Golf with Memorial High School

Finalist for Top Scholar Athlete
Houston, TX

- Top 20 scholar athlete out of all students in the Greater Houston Area
  May 2007